New Hampshire Volunteer Lake Assessment Program

2003 Biennial Report for the Lake Ossipee System

(Berry Bay, Broad Bay, Leavitt Bay, Lower Danforth Pond, Lake Ossipee)

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **OSSIPEE LAKE SYSTEM (Berry Bay, Broad Bay, Lake Ossipee, Leavitt Bay, Lower Danforth Pond),** the program coordinators have made the following observations and recommendations:

Welcome to the New Hampshire Volunteer Lake Assessment Program (VLAP)! While **BROAD BAY** and **LEAVITT BAY** have been sampled through VLAP for many years, this is the first year that **BERRY BAY, LAKE OSSIPEE, AND LOWER DANFORTH POND** have been sampled through the program. As your group continues to participate in VLAP over the years, the database created for your lake/pond will help your monitoring group track water quality trends and will ultimately enable your group and DES to identify potential sources of pollutants from the watershed that may affect lake/pond quality.

As a rule of thumb, *please* try to sample at least once per month during the summer months (June, July, and August). In addition, it may be necessary to conduct rain event sampling at multiple locations along a stream using the bracketing technique to pinpoint sources of pollution. Furthermore, baseline studies could involve bi-weekly or monthly sampling for an extended period of time. DES will let you know if this type of sampling is appropriate.

We understand that future sampling will depend upon volunteer availability, your group's water monitoring goals and funding availability. We would like to point out that **water quality trend analysis is not feasible with only a few data points.** It will take many years to develop a statistically sound set of water quality baseline data. Specifically, after 10 consecutive years of participation in the program, we will be able to analyze the in-lake data with a simple statistical test to determine if there has been a significant change in the annual mean chlorophyll-a concentration, Secchi-disk transparency reading, and phosphorus concentration. Therefore, frequent and consistent sampling will ensure useful data for future analyses.

As part of the state's Lake Survey Program, DES biologists performed a comprehensive lake survey on **BERRY BAY, BROAD BAY, LEAVITT BAY, and LAKE OSSIPEE** this summer. Each of the State's public water bodies are surveyed approximately every ten to fifteen years. In addition to the tests normally carried out by VLAP, biologists tested for certain indicator metals and nitrogen, created a map of the lake/pond bottom contours (referred to as a bathymetric map), and mapped the abundance and distribution of the aquatic plants along the shoreline. DES biologists will also sample each of these basins once during the Winter of 2003-2004. Some data from this lake survey have been included in this report and has been added to the historical database. If you would like a complete copy of the raw data from the lake survey, please contact the DES Limnology Center at (603) 271-3414 or (603) 271- 2658. A final report should be available in 2005 and a copy will be available at any state library.

And finally, to help the reader understand data discussed in this report, it is important to discuss the specifics of the Ossipee System 2003 sampling program. There are numerous tributaries that flow into Lake Ossipee. These tributaries were sampled by the Green Mountain Conservation Group (GMCC) through the University of New Hampshire Cooperative Extension Lay Lakes Monitoring Program. The Ossipee System is comprised of five basins connected by relatively narrow channels. Specifically, water flows from Lake Ossipee to Broad Bay, from Broad Bay to Leavitt Bay, from Leavitt Bay to Berry Bay, and then from Berry Bay to the Ossipee River. Water from Lower Danforth Pond flows into the northern end of Broad Bay. The deep spots of Lake Ossipee, Broad Bay, Leavitt Bay, Berry Bay, and Lower Danforth Pond were sampled through the Department of Environmental Services' Volunteer Lake Assessment Program.

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 mg/m^3.**

Ossipee System Current Year Chlorophyll-a Data (2003)

	Minimum Value (mg/m^3)	Maximum Value (mg/m^3)	Mean Value (mg/m^3)	Comparison to NH Mean	Other Comments
Lake Ossipee	1.68	2.54	2.12	Much less than	Increased gradually from June to Aug.
Lower Danforth Pond	1.99	8.39	4.49	Less than	Increased gradually from June to July. Increased greatly from July to Aug.
Broad Bay	1.26	2.89	2.27	Much less than	Decreased from June to July. Increased from July to August. June and Aug. approx equal.
Leavitt Bay	1.85	2.71	2.30	Much less than	Increased very slightly from June to July. Decreased slightly from July to Aug.
Berry Bay	2.18	2.49	2.34	Much less than	Approx. the same on each sampling event.

Ossipee System Historic Chlorophyll-a Data

	Sampling Period	Overall Trend	Percent Change in annual mean per sampling season
Lake Ossipee	2003	N/A*	N/A*
Lower Danforth Pond	2003	N/A*	N/A*
Broad Bay	1990 to 2003	Stable (ranging between approx. 2 – 3.5 mg/m^3)	No statistically significant overall change since monitoring began.
Leavitt Bay	1990 to 2003	Increasing (worsening)	Increase (worsening) of 4.9% per year since 1990
Berry Bay	2003	N/A*	N/A*

N/A* = Not applicable. This deep spot has been sampled for one season through VLAP. In order to statistically determine trends, at least 10 consecutive sampling seasons of data must be collected.

The current year data show that the annual mean chlorophyll-a concentration at each of the five deep spots this season was ***less than*** the state mean. It is important to point out that the mean annual chlorophyll concentration at the **LOWER DANFORTH POND** deep spot was approximately ***twice as great*** as the mean annual chlorophyll concentration at the other four deep spots sampled.

Overall, the statistical analysis of the historical data shows that the mean annual chlorophyll-a concentration at the **BROAD BAY** deep spot has ***not significantly changed*** (either *continually increased* or *continually decreased*) since monitoring began in **1990**. Specifically, the chlorophyll-a concentration has remained ***relatively stable,*** ranging between approximately **2 and 3.5 mg/m^3**. (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

Overall, the statistical analysis of the historical data show that the mean annual chlorophyll-a concentration at the **LEAVITT BAY** deep spot has ***significantly increased*** since monitoring began. Specifically, the chlorophyll-a concentration has ***worsened*** on average by *approximately* ***4.9 percent*** per sampling season during the sampling period **1990** to **2003.** (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data for **LAKE OSSIPEE, LOWER DANFORTH POND, and BERRY BAY** to objectively determine if there has been a significant change in the annual mean chlorophyll concentration since monitoring began.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

Ossipee System Current Year Transparency Data (2003)

	Minimum Value (meters)	Maximum Value (meters)	Mean Value (meters)	Comparison to NH Mean	Other Comments
Lake Ossipee	3.4	6.2	4.4	Greater than	Increased by 2 meters from June to July. Decreased by 2.5 meters from July to Aug.
Lower Danforth Pond	3.6	4.1	3.9	Slightly greater than	Decreased slightly from June to July. Increased slightly from July to Aug. June and Aug. approx. equal.
Broad Bay	3.6	4.5	4.1	Slightly greater than	Increased from June to July. No August reading.
Leavitt Bay	3.3	4.5	3.8	Slightly greater than	Increased slightly from June to July. Decreased slightly from July to Aug.
Berry Bay	4.0	4.6	4.3	Slightly greater than	Increased slightly from June to July. Decreased slightly from July to Aug.

Ossipee System Current Historic Transparency Data (2003)

	Sampling Period	Overall Trend	Percent Change in annual mean per sampling season
Lake Ossipee	2003	N/A*	N/A*
Lower Danforth Pond	2003	N/A*	N/A*
Broad Bay	1990 to 2003	Decreasing (worsening)	Decrease (worsening) of approximately 4.0% per year since 1990.
Leavitt Bay	1990 to 2003	Overall Stable (Fluctuating, but no continual increase or continual decrease since monitoring began.)	No statistically significant overall change since monitoring began.
Berry Bay	2003	N/A*	N/A*

N/A* = Not applicable. This deep spot has been sampled for one season through VLAP. In order to statistically determine trends, at least 10 consecutive sampling seasons of data must be collected.

The current year data show that the in-lake transparency at each of the five deep spots on each sampling event was ***greater than*** the state mean. The difference between the minimum and maximum mean annual transparency among the five deep spots was **0.5 meters**.

Overall, the statistical analysis of the historical data show that the mean annual transparency at the **BROAD BAY** deep spot has ***significantly decreased*** since monitoring began. Specifically, the in-lake transparency in **BROADY BAY** has ***decreased*** (meaning ***worsened***) on average by ***approximately 4.0 percent*** per sampling season during the sampling period **1990** to **2003**. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Overall, the statistical analysis of the historical data show that the mean annual transparency at the **LEAVITT BAY** deep spot has ***not significantly changed*** (either *increased* or *decreased*) since monitoring began in **1990**. Specifically, the in-lake transparency in **LEAVITT BAY** has ***fluctuated***, but has not *continually increased* or *continually decreased* since monitoring began. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

As discussed previously, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data for **LAKE OSSIPEE, LOWER DANFORTH POND, and BERRY BAY** to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

Ossipee System Current Year Epilimnetic Phosphorus Data (2003)

	Minimum Value (ug/L)	Maximum Value (ug/L)	Mean Value (ug/L)	Comparison to NH Mean	Other Comments
Lake Ossipee	6	8	7	Much less than	Stable from June to July. Slight decrease from July to Aug.
Lower Danforth Pond	11	12	11	Equal to	Slight increase from June to July. Stable from July to Aug.
Broad Bay	5	9	7	Much less than	Increase from June to July. Slight decrease from July to Aug.
Leavitt Bay	7	8	7	Much less than	Slight increase from June to July. Stable from July to Aug.
Berry Bay	6	7	6	Much less than	Slight increase from June to July. Stable from July to Aug.

Ossipee System Current Year Hypolimnetic Phosphorus Data (2003)

	Minimum Value (ug/L)	Maximum Value (ug/L)	Mean Value (ug/L)	Comparison to NH Mean	Other Comments
Lake Ossipee	6	7	6	Much less than	Slight increase from June to July. Stable from July to Aug.
Lower Danforth Pond	17	29*	24*	Much greater than	Large increase from June to July. Slight decrease from July to Aug.
Broad Bay	6	9	7	Much less than	Gradual increase from June to July and from July to August.
Leavitt Bay	6	9	7	Much less than	Gradual increase from June to July and July to Aug.
Berry Bay	7	9	8	Much less than	Gradual decrease from June to July and from July to Aug.

* = The turbidity of these samples was elevated. Please refer to the discussion of Table 11 for further explanation.

Ossipee System Historic Epilimnetic Phosphorus Data

	Sampling Period	Overall Trend	Percent Change in annual mean per sampling season
Lake Ossipee	2003	N/A*	N/A*
Lower Danforth Pond	2003	N/A*	N/A*
Broad Bay	1990 to 2003	Stable (Ranging between approx 6 and 10 ug/L)	There has not been a continual increase or continual decrease since monitoring began
Leavitt Bay	1990 to 2003	Stable (Ranging between approx 4 and 8 ug/L)	There has not been a continual increase or continual decrease since monitoring began
Berry Bay	2003	N/A*	N/A*

Ossipee System Historic Hypolimnetic Phosphorus Data

	Sampling Period	Overall Trend	Percent Change in annual mean per sampling season
Lake Ossipee	2003	N/A*	N/A*
Lower Danforth Pond	2003	N/A*	N/A*
Broad Bay	1990 to 2003	Stable (Ranging between approx 6 and 10 ug/L)	There has not been a continual increase or continual decrease since monitoring began
Leavitt Bay	1990 to 2003	Stable (Ranging between approx 6 and 10 ug/L)	There has not been a continual increase or continual decrease since monitoring began
Berry Bay	2003	N/A*	N/A*

N/A* = Not applicable. This deep spot has been sampled for one season through VLAP. In order to statistically determine trends, at least 10 consecutive sampling seasons of data must be collected.

The current year data for the epilimnion and the hypolimnion show that the mean annual phosphorus concentration was ***less than*** the state median at each deep spot except for **LOWER DANFORTH POND**.

Specifically, at the **LOWER DANFORTH POND** deep spot, the mean annual phosphorus concentration in the epilimnion was ***equal to*** the state median, while the mean annual phosphorus concentration in the hypolimnion was ***almost twice as much*** as the state median.

Overall, the statistical analysis of the historical data at **the BROAD BAY and LEAVITT BAY** deep spot shows that the phosphorus concentration in the epilimnion and the hypolimnion in these two locations has ***not significantly changed*** (either continually *increased* or *decreased*) since monitoring began in **1990**. (Refer to Appendix E for the statistical analysis explanation and data.)

TABLE INTERPRETATION

- **Table 2: Phytoplankton**
  Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake/pond.

Ossipee System Current Year Phytoplankton Dominant Species (2003)

	June 19	July 15	August 12
Lake Ossipee	*Rhizosolenia* (diatom) *Tabellaria* (diatom)	*Rhizosolenia* (diatom) *Chrysosphaerella* (golden-brown) *Mallomonas* (golden-brown)	*Asterionella* (diatom) *Chrysosphaerella* (golden-brown) *Tabellaria* (diatom)
Lower Danforth Pond	*Tabellaria* (diatom) *Anabaena* (cyanobacteria) *Ceratium* (dinoflagellate)	*Synura* (golden-brown) *Dinobryon* (golden-brown) *Tabellaria* (diatom)	*Dinobryon* (golden-brown) *Synura* (golden-brown) *Hydrodictyon* (green)
Broad Bay	*Rhizosolenia* (diatom) *Dinobryon* (golden-brown)	*Chrysosphaerella* (golden-brown) *Asterionella* (diatom) *Dinobryon* (golden-brown)	*Asterionella* (diatom) *Tabellaria* (diatom) *Chrysosphaerella* (golden-brown)
Leavitt Bay	*Rhizosolenia* (diatom) *Dinobryon* (golden-brown)	*Chrysosphaerella* (golden-brown) *Uroglenopsis* (golden-brown) *Dinobryon* (golden-brown)	*Chrysosphaerella* (golden-brown) *Asterionella* (diatom) *Tabellaria* (diatom)
Berry Bay	*Rhizosolenia* (diatom) *Dinobryon* (golden-brown)	*Chrysosphaerella* (golden-brown) *Uroglenopsis* (golden-brown) *Dinobryon* (golden-brown)	*Chrysosphaerella* (golden-brown) *Asterionella* (diatom) *Tabellaria* (diatom)

Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typically found in New Hampshire's less productive lakes and ponds.

An overabundance of cyanobacteria (previously referred to as blue-green algae) indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance.

In June, a small amount of the cyanobacterium ***Anabaena*** was observed in the **BROAD BAY, LEAVITT BAY,** and **BERRY BAY** plankton samples. In addition, a small amount of the cyanobacterium ***Microcystis*** was observed in the **BERRY BAY** sample.

In July, a small amount of the cyanobacterium ***Anabaena*** was observed in the **LAKE OSSIPEE, LOWER DANFORTH POND, and BERRY BAY** samples. In addition, a small amount of ***Microcystis*** was observed in the **BERRY BAY** sample.

In August, a small amount of ***Anabaena*** was observed in the **LAKE OSSIPEE, LOWER DANFORTH POND, BROAD BAY, and LEAVITT BAY** samples. In addition, a small amount of ***Microcystis*** was observed in the **BROAD BAY, LEAVITT BAY, and BERRY BAY samples**.

Anabaena and Microcystis, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.

Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur. During September of 2003, a few lakes and ponds in the southern portion of the state experienced cyanobacteria blooms. This was likely due to phosphorus loading to these waterbodies. As mentioned previously, many weeks during the Spring and Summer of 2003 were rainy, which likely resulted in a large amount of phosphorus loading to surface waters.

The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

- **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean pH at the deep spot this season ranged from **6.03** in the hypolimnion to **6.79** in the epilimnion, which means that the water is ***slightly acidic.*** When organic matter near the lake bottom is decomposed, acidic by-products are produced. This likely explains the lower pH (meaning higher acidity) in the hypolimnion.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

- **Table 5: Acid Neutralizing Capacity**

Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire's lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are "highly sensitive" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.
The mean annual Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) at **LAKE OSSIPEE, BROAD BAY, LEAVITT BAY, and BERRY BAY** ranged from **4.68 to 5.03 mg/L**, which is ***less than*** the state mean, and indicates that the surface water in these locations is ***critically sensitive*** to acidic inputs.

The mean annual ANC in epilimnion of **LOWER DANFORTH POND** was **8.63 mg/L**, which is ***slightly greater than*** the state mean, and indicates that the surface water in this location is ***highly sensitive*** to acidic inputs.

- **Table 6: Conductivity**

Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean annual conductivity in epilimnion at each of the deep spots ranged from **46.2 (LAKE OSSIPEE)** to **52.4 (LOWER DANFORTH POND)**. These values are relatively ***low*** and ***less than*** the state mean.

While the conductivity levels in the Ossipee System are ***relatively low,*** historical data collected at the **BROAD BAY** and **LEAVITT BAY** deep spots show that the epilimnetic conductivity has ***gradually increased*** since monitoring began in 1990. Specifically, the epilimnetic conductivity at the **BROAD BAY** and **LEAVITT BAY** deep spots has ***increased*** (meaning ***worsened***) on average by ***approximately 1.6 and 1.7 percent respectively*** per sampling season during the sampling period **1990** to **2003**. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

We recommend that your monitoring group conduct stream surveys and storm event sampling along the inlet(s) with elevated conductivity. This additional sampling may help to pinpoint the sources of increasing conductivity in the lake basins. (Please note that tributary sampling was conducted through the UNH Cooperative Extension Lay Lakes Monitoring Program during the Summer of 2003. This data was not available to DES when this report was written, therefore, we do not have an indication of what tributaries may be contributing to the increasing in-lake conductivity levels.)

For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

- **Table 8: Total Phosphorus**
  Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  As discussed previously, tributary sampling was conducted through the UNH Cooperative Extension Lay Lakes Monitoring Program during the Summer of 2003. Therefore, tributary phosphorus data was not available to DES when this report was written. Consequently, we do not have an indication of the phosphorus concentration in the tributaries that are flow into the Ossipee system.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  On the **June 19** sampling event, the DES biologist assisted the volunteer monitors with collecting a dissolved oxygen and temperature profile at each of the lake deep spots.

  The dissolved oxygen concentration in the bottom meter **at each of the deep spots** (aside from the **LOWER DANFORTH POND** deep spot) was ***relatively high***. Specifically, the dissolved oxygen at each of the deep spots on the **June** sampling event was as follows: **LAKE OSSIPEE** (15.0 meters) 10.8 mg/L; **BROAD BAY** (16.0 meters) 14.2 mg/L; **LEAVITT BAY** (10.0 meters) 8.6 mg/L; and **BERRY BAY** (8.5 meters) 9.9 mg/L. This is the sign of the relative good health of these waterbodies.

  However, the dissolved oxygen concentration in the hypolimnion at the **LOWER DANFORTH POND** deep spot (8.5 meters) on the **June** sampling event was 1.3 mg/L, which is ***relatively low***. In addition, the phosphorus concentration in the hypolimnion (the lower layer) on the **June** sampling event was ***greater than*** in the epilimnion (the upper layer). Furthermore, as the summer progressed, the phosphorus concentration in the hypolimnion ***increased*** while the concentration in the epilimnion remained ***relatively stable***.

These data suggest that the process of ***internal phosphorus loading*** is occurring in the hypolimnion of **LOWER DANFORTH POND**. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(it was depleted to 1.3 mg/L in June this season)**, the phosphorus that is normally bound up with metals (like iron and aluminum) in the sediment may be re-released into the water column, which is referred to as ***internal phosphorus loading.***

Internal phosphorus loading may explain why the phosphorus concentration in the hypolimnion at **LOWER DANFORTH POND** is ***greater*** than the phosphorus concentration in epilimnion. Since an internal source of phosphorus in the lake/pond may be present, it is even more important that watershed residents act proactively to minimize external phosphorus loading from the watershed.

We recommend that the annual biologist for 2004 be scheduled during ***July*** *so that we can measure the dissolved oxygen concentration at the deep spot later in the sampling season.*

- **Table 11: Turbidity**

  Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  The turbidity of the **LOWER DANFORTH POND** hypolimnetic (lower layer) sample was ***elevated*** on the **July 15** and **August 12** sampling events (10.1 and 15.1 NTUs, respectively). This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, please check to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

- **Table 12: Bacteria (*E.coli*)**

  Table 12 lists the current year data for bacteria *(E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **MAY** be present. If sewage is present in the water, potentially harmful disease-causing organisms may also be present.

  On the **August 12** sampling event, in-lake *E.coli* samples were taken on **BROAD BAY** at the ***Beach Club, Danforth Brook***, and at the ***Sullivan*** location. The results were all ***very low*** (10 counts or fewer per 100 mL), which is ***much less than*** the state standard of 406 counts per 100 mL for recreational surface waters that are not designated beaches and 88 counts per 100 mL for surface waters that are designated public beaches.

  If you are particularly concerned about bacteria levels in these locations, you may want to conduct *E.coli* testing next season on a weekend during heavy beach use and also after a rain event. Since *E.coli* die quickly in cool waters, testing is most accurate and most representative of the health risk to bathers when the source (humans, animals, or waterfowl) is present. Typically, *E.coli* levels are highest during heavy bather loads, after rain events, and during periods of time when waterfowl are present.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake/pond, the biologists trained your group how to collect in-lake samples. In future seasons, the Biologist will conduct a “Sampling Procedures Assessment Audit” for your monitoring group. Specifically, the biologist will observe the performance of your monitoring group while sampling and will fill out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor’s Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake conditions.

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an ***excellent*** job when collecting and submitting samples to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

NOTES

BERRY BAY

- **Biologist's Note (6/19/03):** Great water quality!

BROAD BAY

- **Monitor's Note (8/12/03):** Conditions were too wet for a data Sheet
- **Biologist's Note (6/19/03):** Great water quality!

LOWER DANFORTH POND

- **Biologist's Note (6/19/03):** The total phosphorous in the hypolimnion is slightly elevated.

LEAVITT BAY

- **Biologist's Note (6/19/03):** Great water quality!

LAKE OSSIPEE

- **Biologist's Note (6/19/03):** Great water quality!

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, ARD-32, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, *NHDES-WD 97-8*, NHDES Booklet, (603) 271-3503.

Camp Road Maintenance Manual: A Guide for Landowners. KennebecSoil and Water Conservation District, 1992, (207) 287-3901.

Comprehensive Shoreland Protection Act, RSA 483-B, *WD-SP-5,* NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-5.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Impacts of Development Upon Stormwater Runoff, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or www.des.state.nh.us/factsheets/wqe/wqe-7.htm

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, *WD-BB-9*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

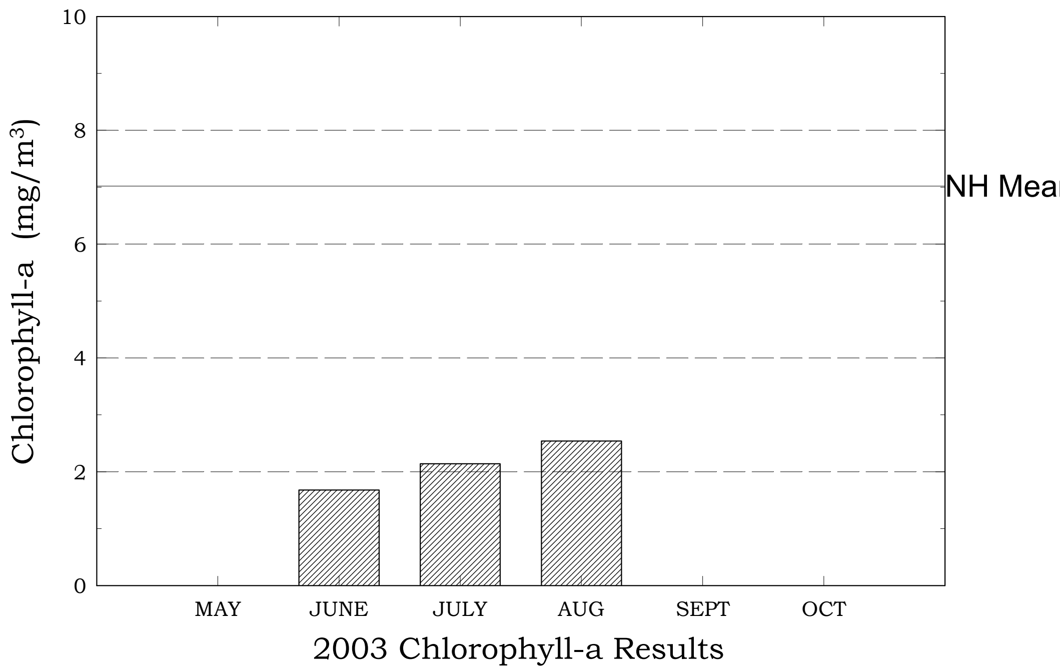
Sand Dumping - Beach Construction, *WD-BB-15*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

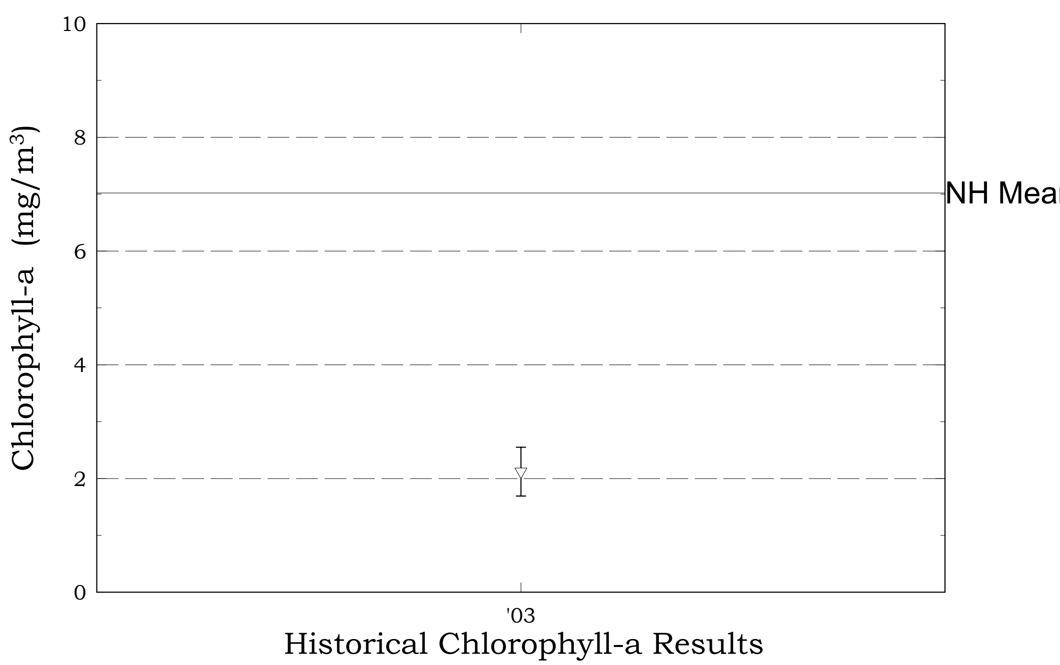
Swimmers Itch, *WD-BB-2*, NHDES Fact Sheet, (603) 271-3503 or *www.des.state.nh.us/factsheets/bb/bb-2.htm.*

Through the Looking Glass: A Field Guide to Aquatic Plants. North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

Lake Ossipee, Ossipee

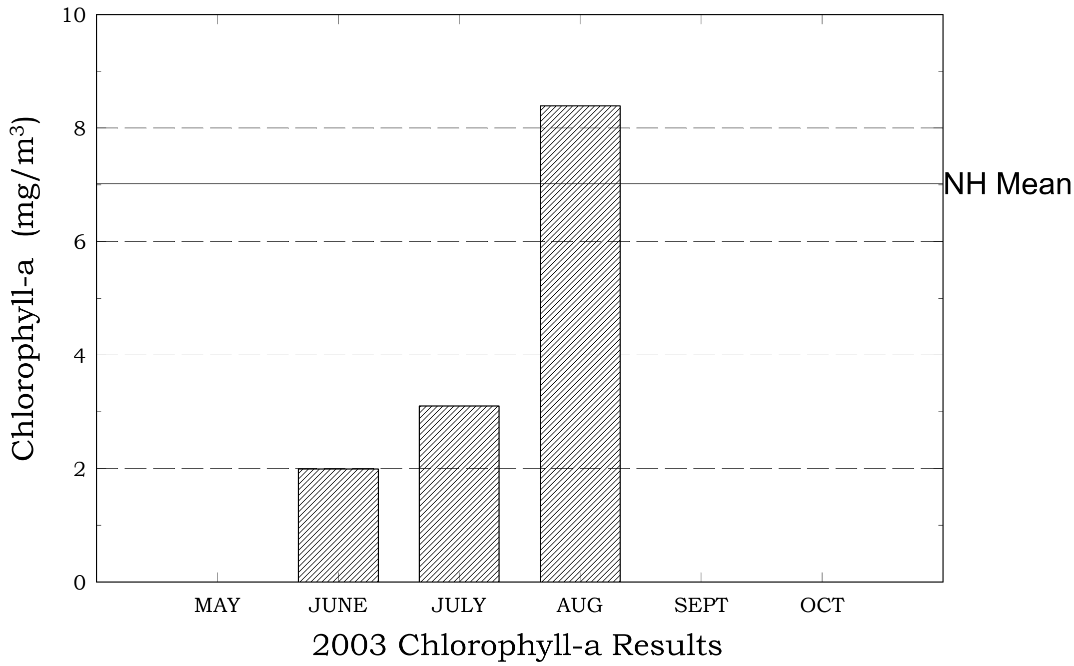
Figure 1. Monthly and Historical Chlorophyll-a Results

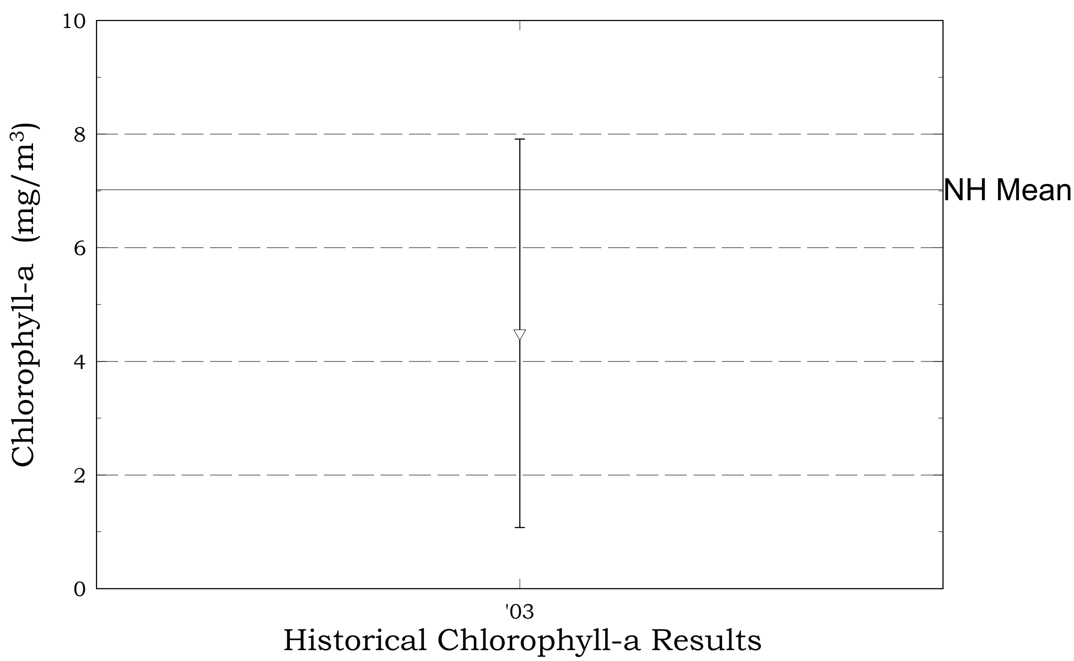




Lower Danforth Pond, Freedom

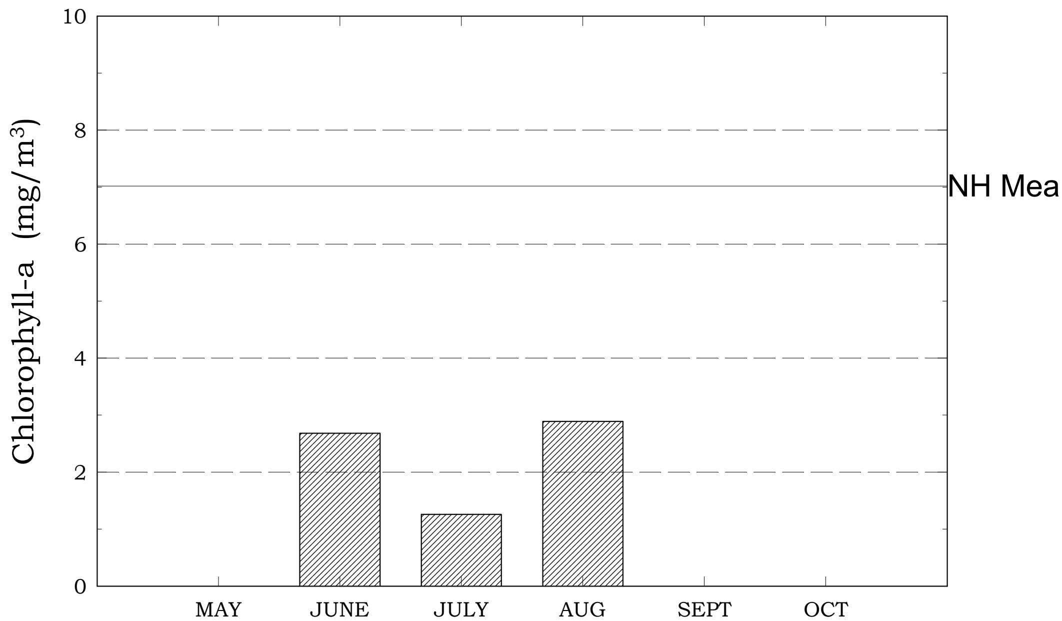
Figure 1. Monthly and Historical Chlorophyll-a Results



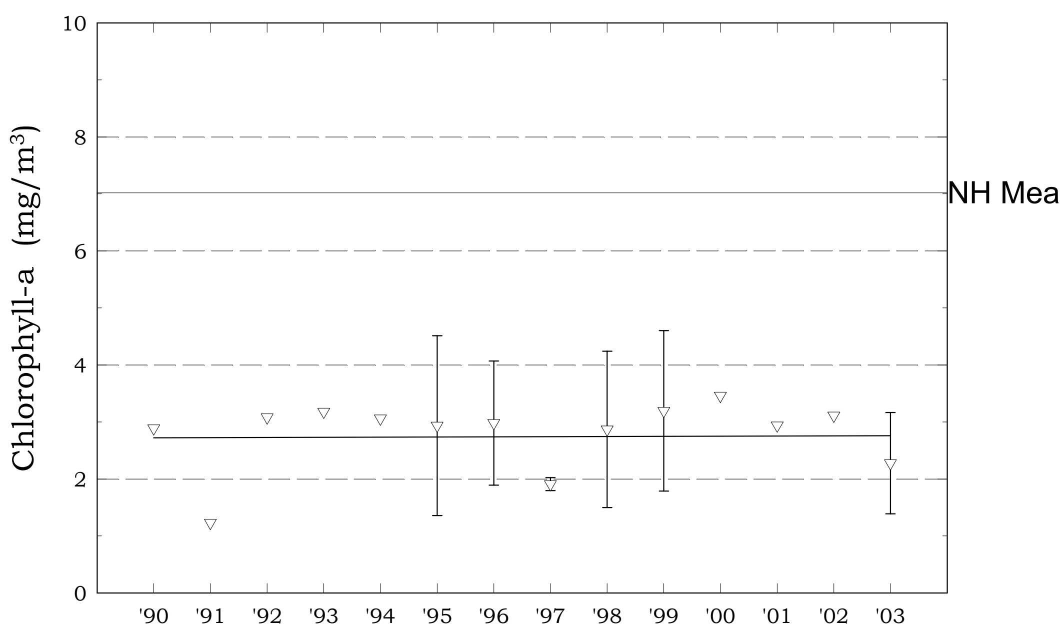


Broad Bay, Ossipee

Figure 1. Monthly and Historical Chlorophyll-a Results



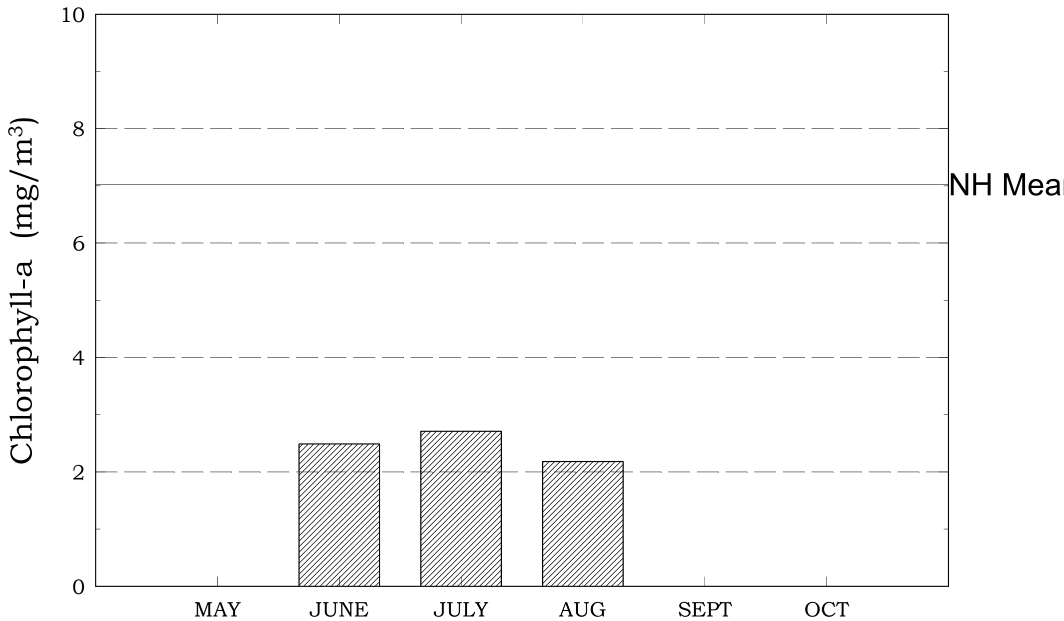
2003 Chlorophyll-a Results



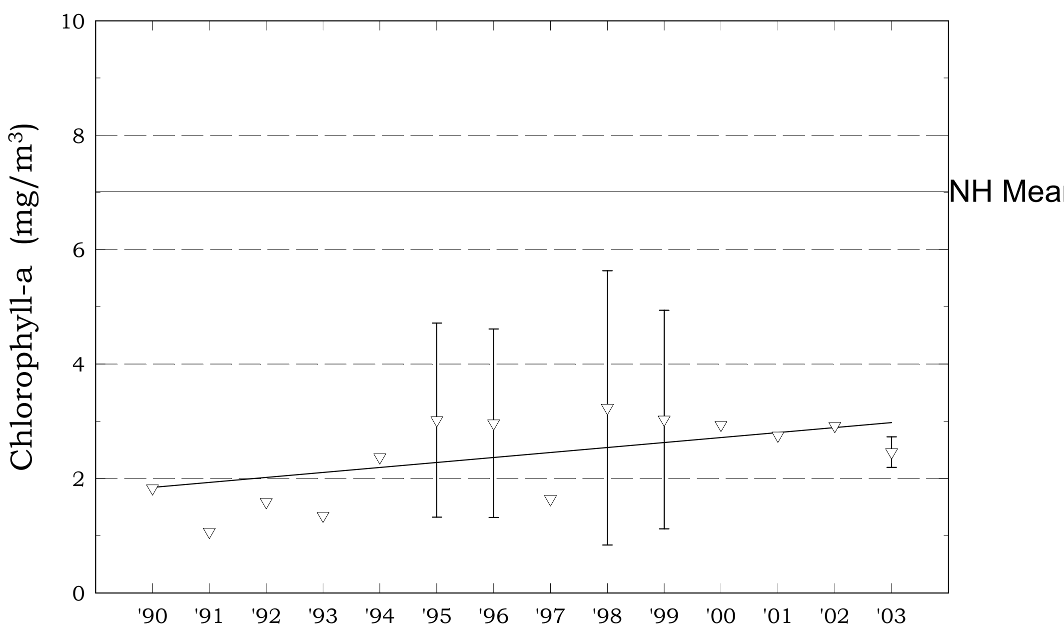
Historical Chlorophyll-a Results

Leavitt Bay, Ossipee

Figure 1. Monthly and Historical Chlorophyll-a Results



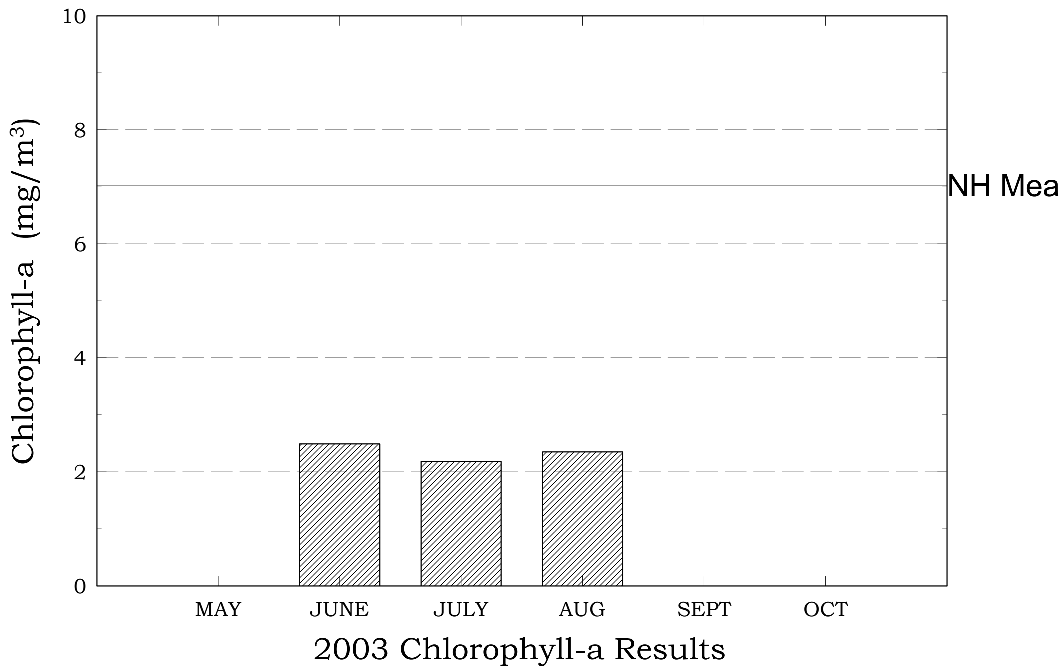
2003 Chlorophyll-a Results

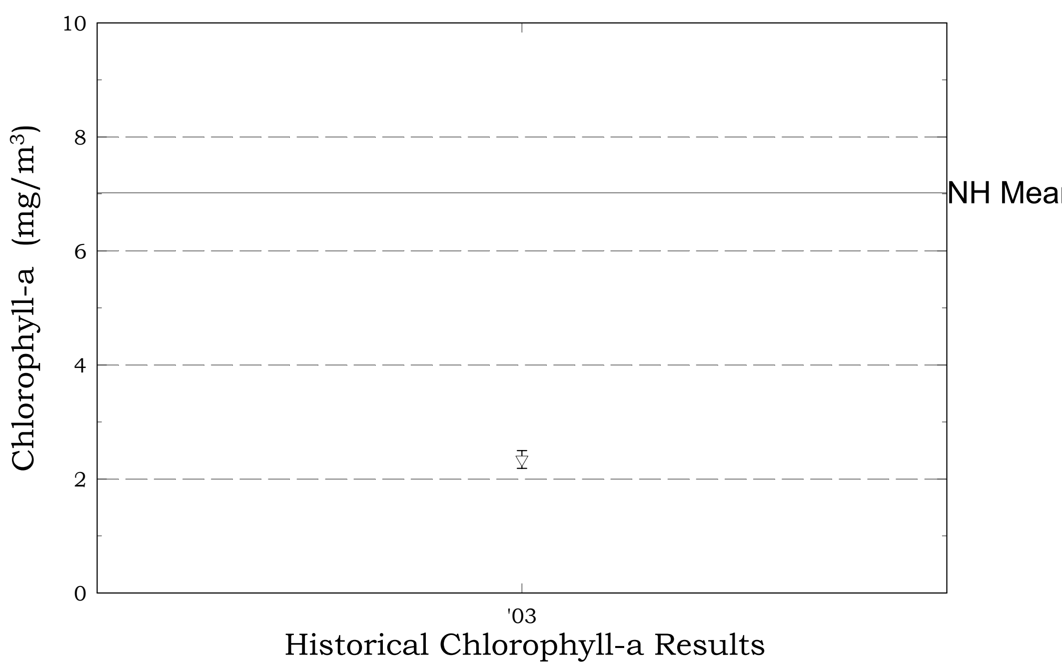


Historical Chlorophyll-a Results

Berry Bay, Freedom

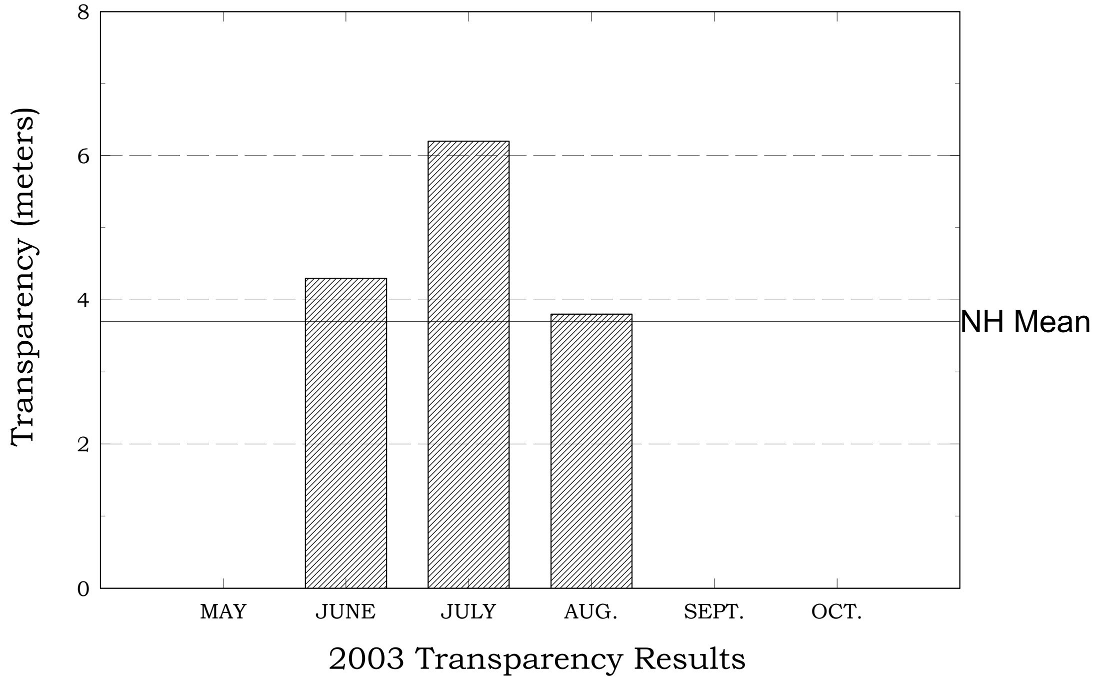
Figure 1. Monthly and Historical Chlorophyll-a Results

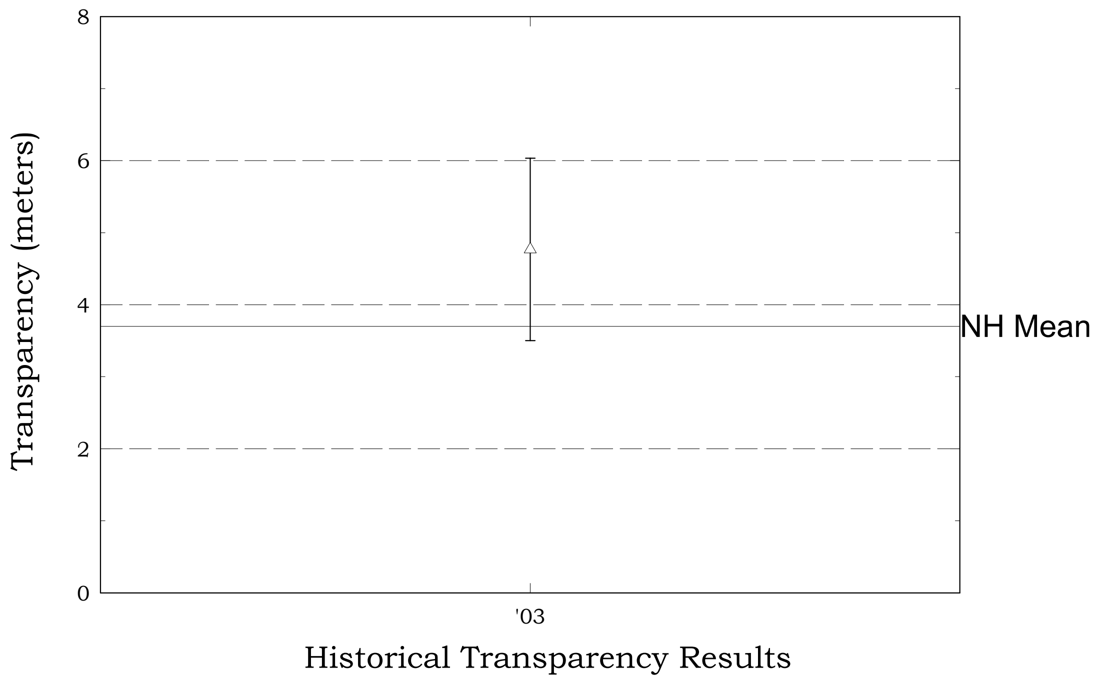




Lake Ossipee, Ossipee

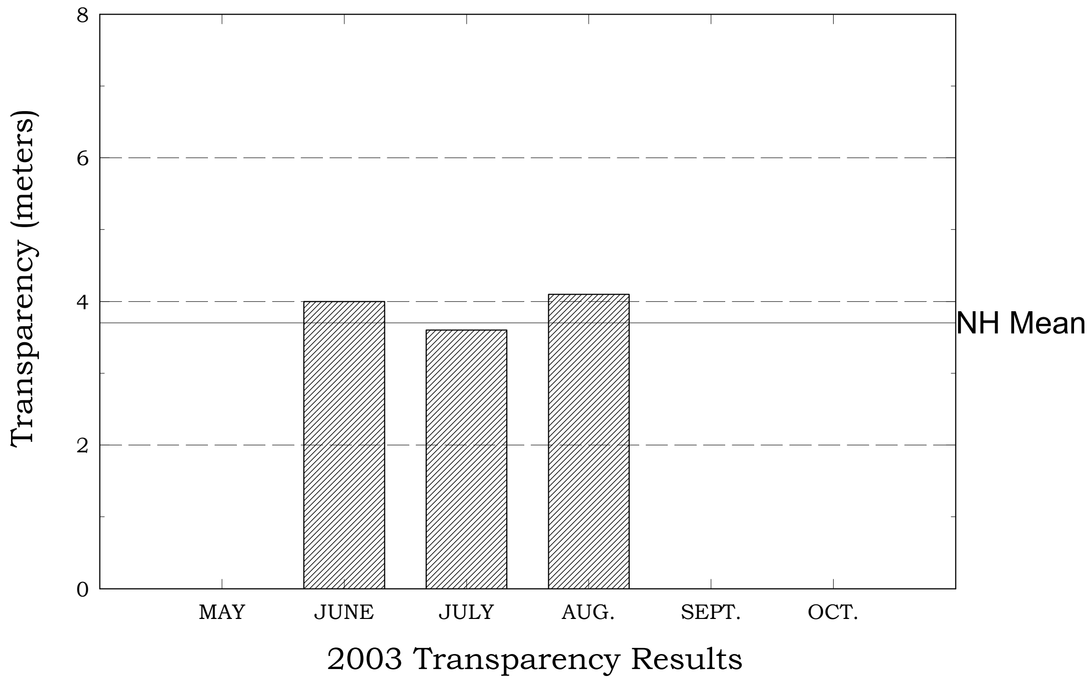
Figure 2. Monthly and Historical Transparency Results

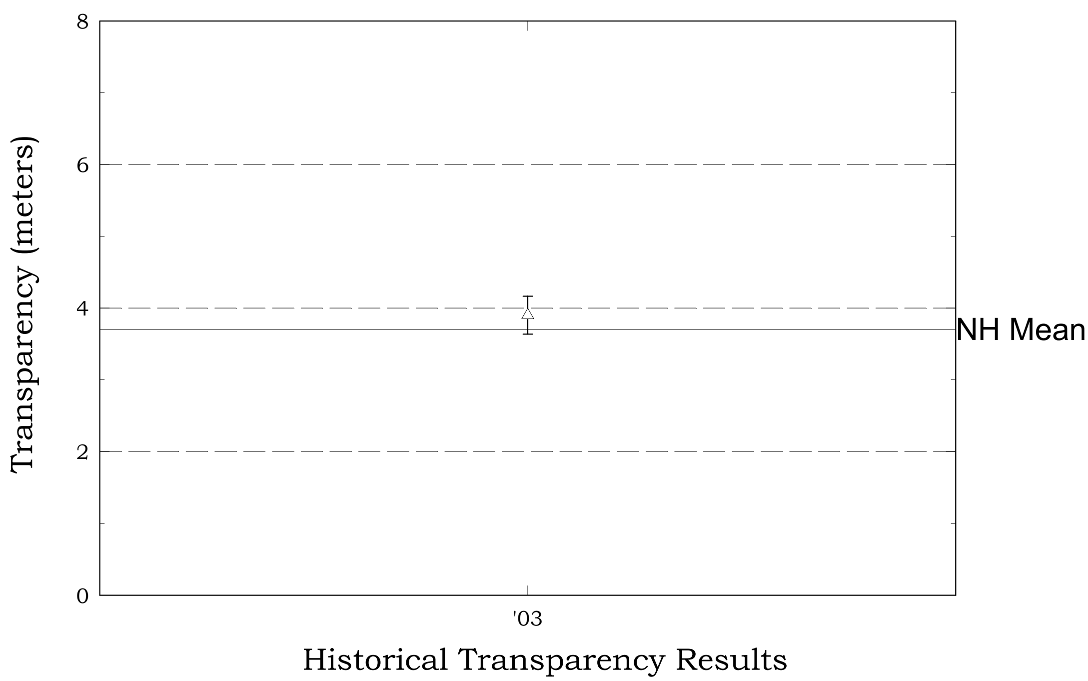




Lower Danforth Pond, Freedom

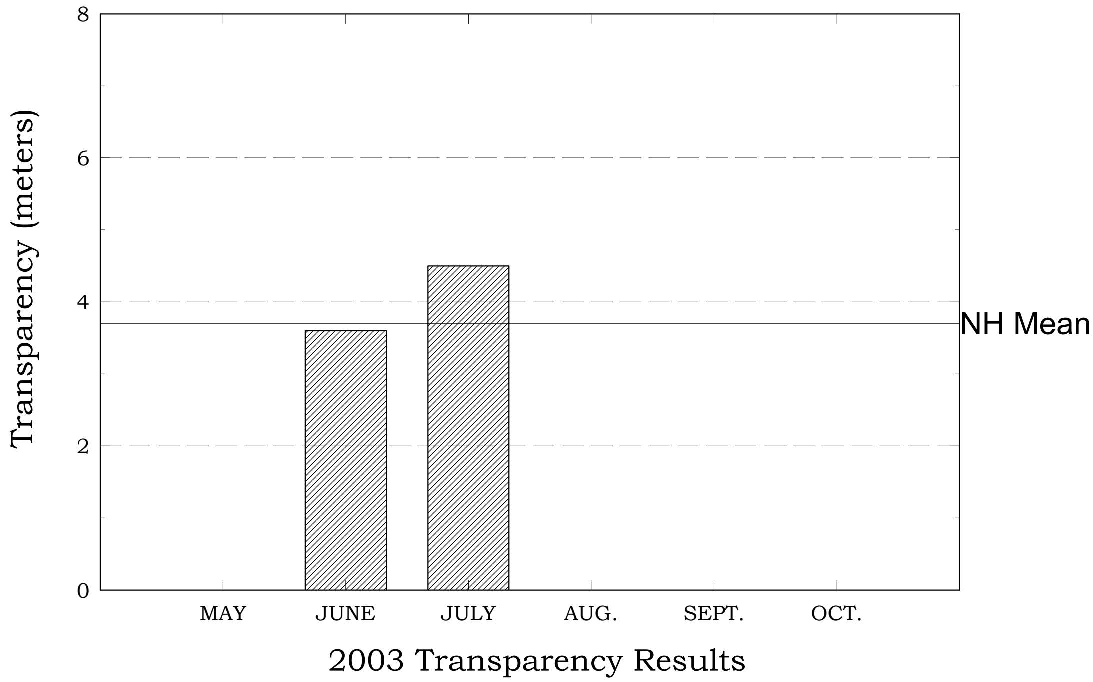
Figure 2. Monthly and Historical Transparency Results

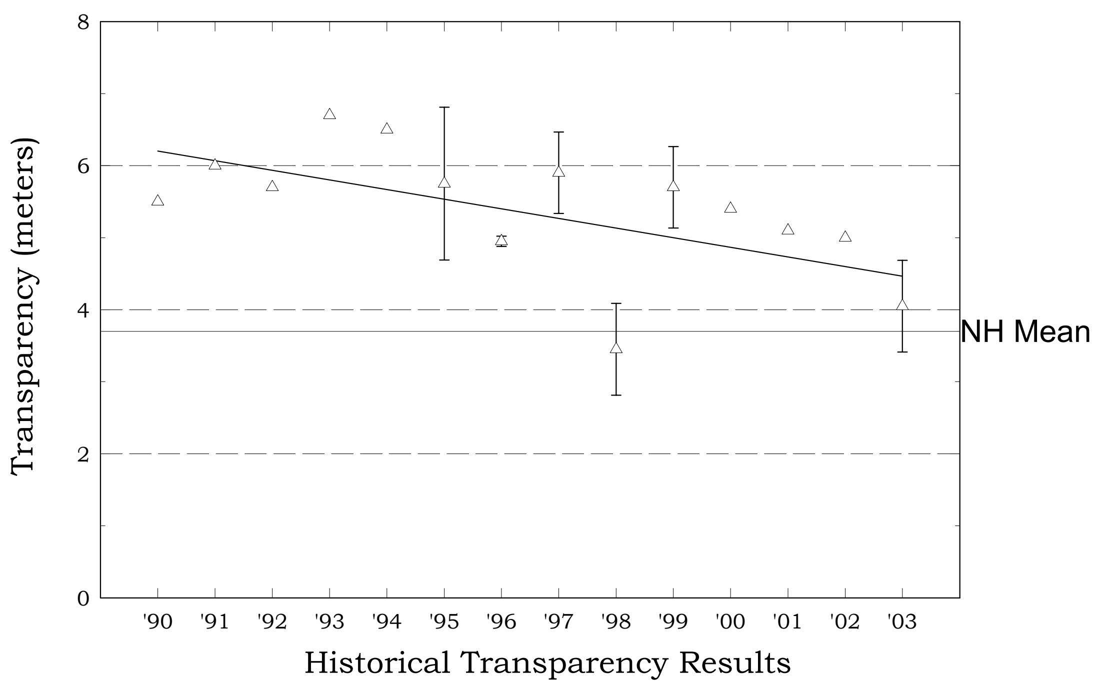




Broad Bay, Ossipee

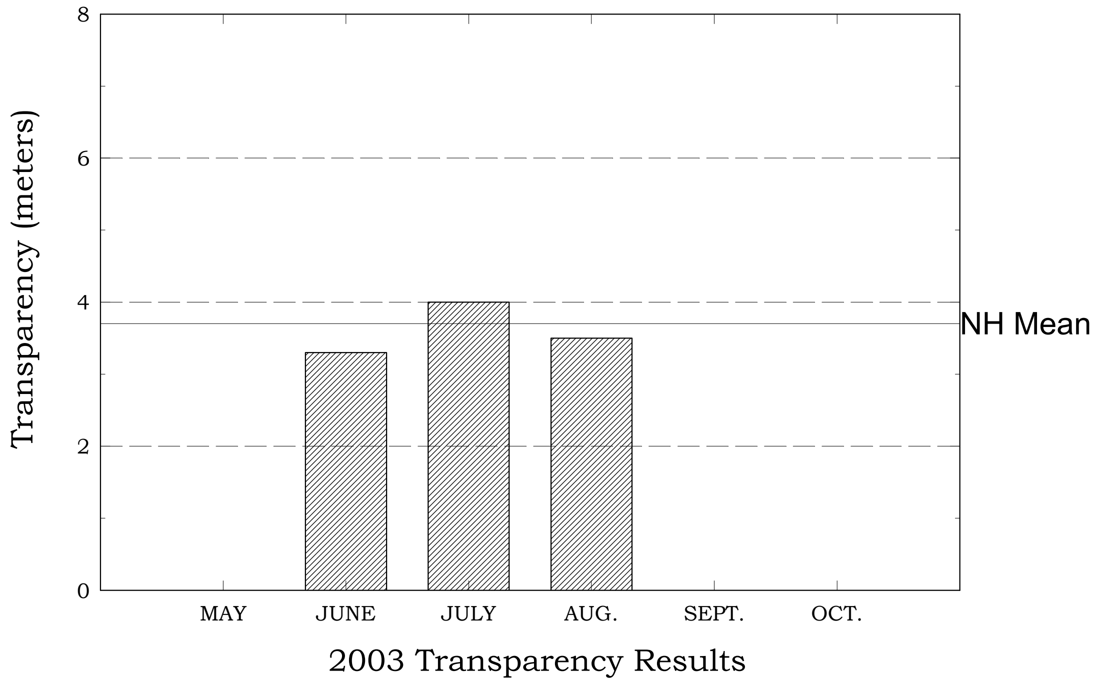
Figure 2. Monthly and Historical Transparency Results

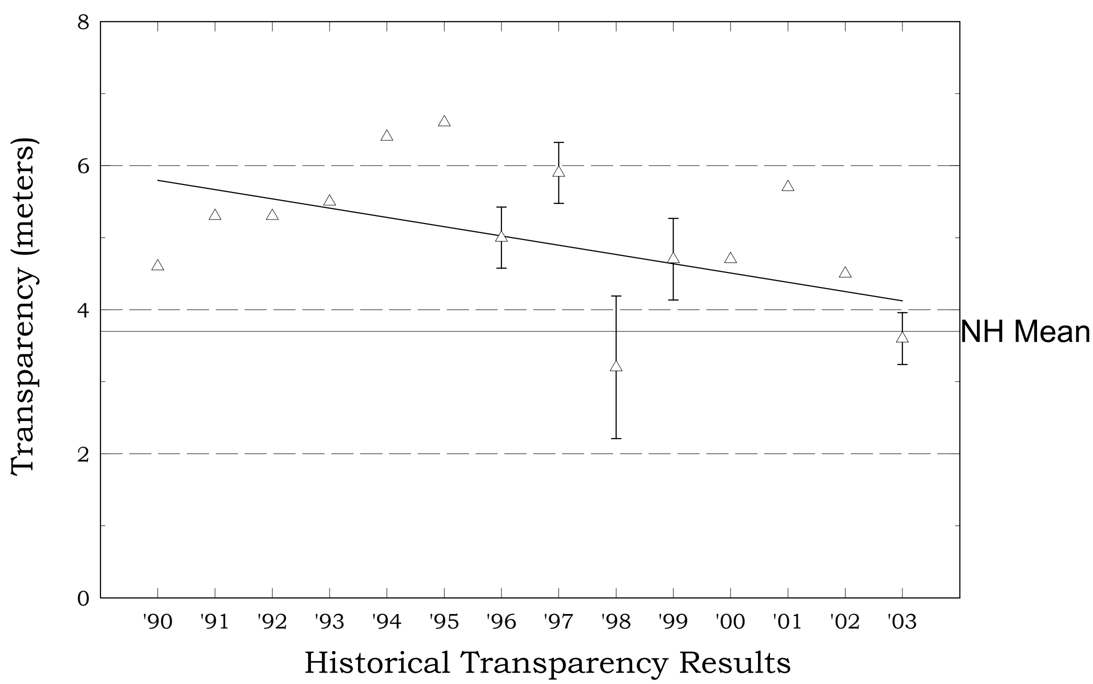




Leavitt Bay, Ossipee

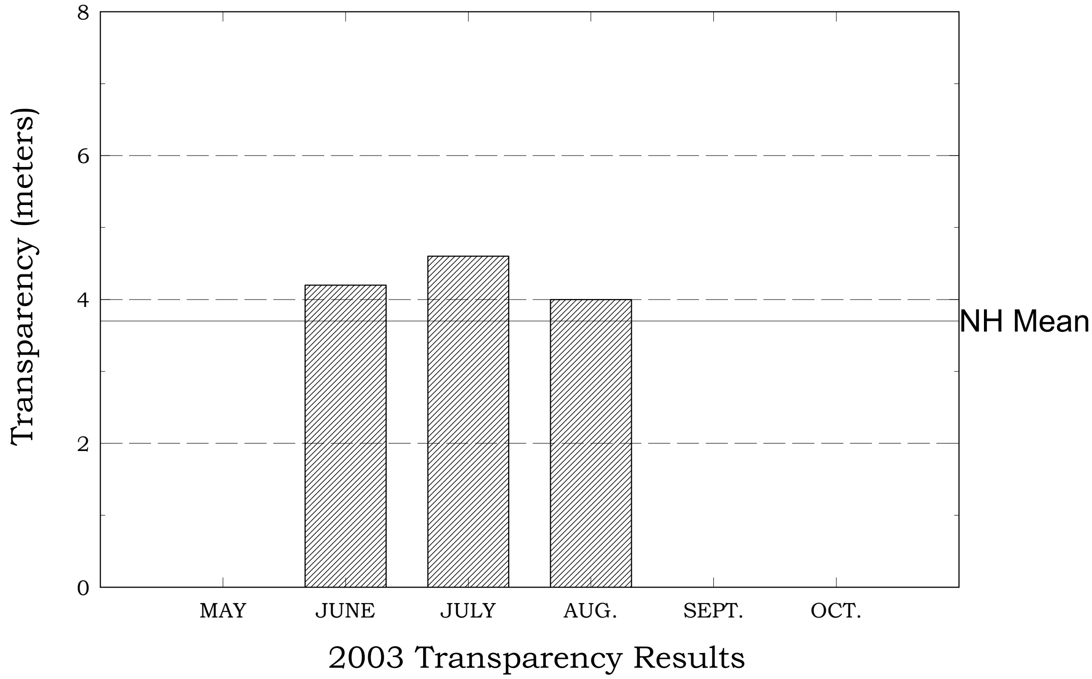
Figure 2. Monthly and Historical Transparency Results

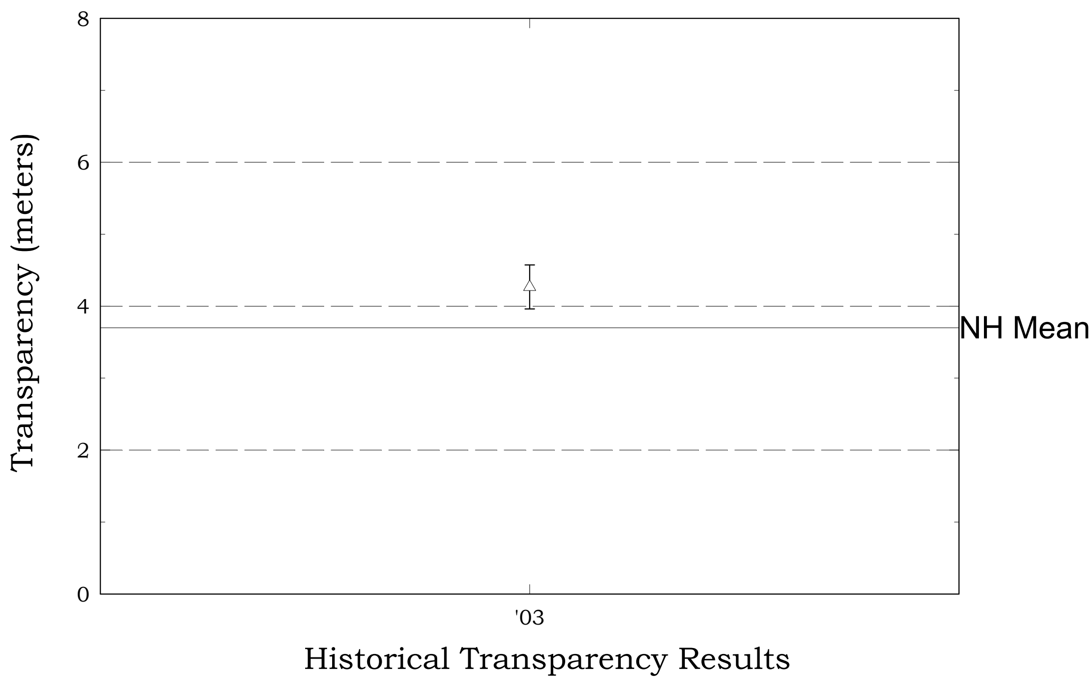




Berry Bay, Freedom

Figure 2. Monthly and Historical Transparency Results





Lake Ossipee, Ossipee

Figure 3. Monthly and Historical Total Phosphorus Data.